HUMAN RESOURCES RESEARCH COUNCIL

computers in Alberta schools

Foreword

During 1969 and 1970 the Education Studies Area of HRRC operated a research and development program on the use of computers in education.

For a variety of reasons, mainly its high cost, this program of work was phased out. The research examined some of the dominant concerns in the field today: the training of teachers; the use of computer technology for instruction and administration; the development of new hardware and software; and the use of computers in student counselling.

Computers in Alberta Schools

is a summary of the HRRC—sponsored work prepared for interested professionals and members of the public.

A diary-anecdotal record of one teacher's experiences with the trial placement of a terminal is presented at length. An examination is made of the ways in which computers can be used to improve the education process—as a specific aid to individualized instruction, in management, and in vocational counselling.

A list of HRRC-funded studies is included. Anyone interested in obtaining further information is asked to contact HRRC or the principal investigator.

Foreword

During 1969 and 1970 the Education Studies Area of HRRC operated a research and development program on the use of computers in education.

For a variety of reasons, mainly its high cost, this program of work was phased out. The research examined some of the dominant concerns in the field today: the training of teachers; the use of computer technology for instruction and administration; the development of new hardware and software; and the use of computers in student counselling.

Computers in Alberta Schools

is a summary of the HRRC—sponsored work prepared for interested professionals and members of the public.

A diary-anecdotal record of one teacher's experiences with the trial placement of a terminal is presented at length. An examination is made of the ways in which computers can be used to improve the education process—as a specific aid to individualized instruction, in management, and in vocational counselling.

A list of HRRC-funded studies is included. Anyone interested in obtaining further information is asked to contact HRRC or the principal investigator.

Introduction

Computers are becoming increasingly important not only for their capability in carrying out mathematical tasks but for their application in many fields of activity. The Science Council of Canada has suggested that one important direction for science in Canada should be towards computer applications in medicine and in education.

If this is so, what is being done in Alberta concerning the use of computers in education? Will teachers be able to make use of this tool in conjunction with their classroom activities? Are there really computers which can teach? How much will it cost the taxpayer?

Computers differ greatly in size and in their capacity to be used for instructional purposes. Since the needs of instruction are very specific and demanding it is only in the last five years that computer systems showing a potential for classroom use have been developed.

Children learn not only through the printed word, but also through the use of audio and visual material and through their own direct participation in the learning process. Therefore, a computer must certainly have the power to handle the printed word, (preferably with special alphabets for teaching foreign languages), to present visual images, and be able to play vocal and other sounds to the students. All these capabilities should be coordinated by someone familiar with learning processes, the subject matter, the characteristics of the students, and with the computer itself.

The cost of computing has steadily decreased during the last two years, as have capital or rental costs. Predictions are that overall costs will continue to decrease, computers will continue to get smaller, and that within the next 15 years the industry will be the third largest in North America.

One university in the United States is well on its way to implementing a computer teaching system which will simultaneously give instruction to 4,000 students. It is estimated that this very large system will cost about 40 cents per student per hour of instruction, while the capital investment in computing equipment will be around 10 million dollars.

Present costs for instruction using systems which already exist vary from $1.50 to about $5.00 per hour.

These costs must be judged not only against current educational costs but also against projected costs for the future. The cost of education in Canada has increased at twice the rate of the gross national product and is now in excess of 8% of the gross national product. Can we continue very much longer with the old methods of instruction?

Both teachers and parents are concerned that the present educational system needs to be overhauled, that better provision needs to be made for both the individualization of instruction and for the social aspects of schooling. It is here that the new applications of computer technology may prove themselves.

Clearly, this cannot mean a discarding of conventional teaching methods (and teachers).

But it does mean that computers can no longer be relegated to the secondary—albeit powerful—role of administrative processing machines.

The role of computers in schools must henceforth be positive: both the limits and the potential of technology must be clearly acknowledged.

Computers can help educators if they are aware of and able to use their capabilities in the classroom.

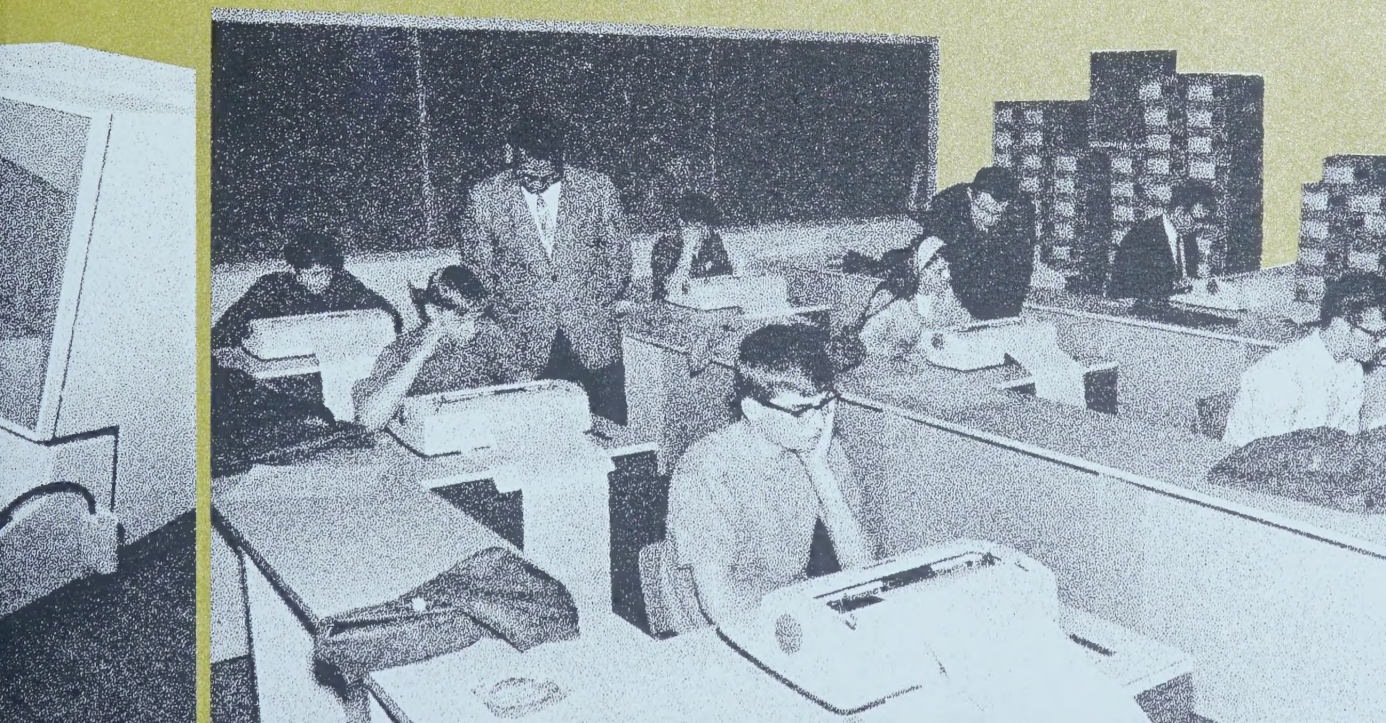
Computers can help better to individualize instruction and create an educational environment more conducive to the growth and development of learners.

By using computer technology to support, supplement and extend the capabilities of teachers, a new dimension will be added to the teaching-learning process.

Current Research

At present, there are at least two computers which are being operated solely for the purpose of investigating their usefulness in the teaching situation. One is at the University of Alberta, Division of Educational Research Services and the other at the University of Calgary, Faculty of Education Computer Applications Unit.

The computer being used at The University of Alberta can present textual material, pictures and tape recordings. It has 16 student learning



stations each composed of a television screen, a "pencil" which can be used to point at the screen, a typewriter-like keyboard, a system for projecting color pictures and an audio-tape recorder.

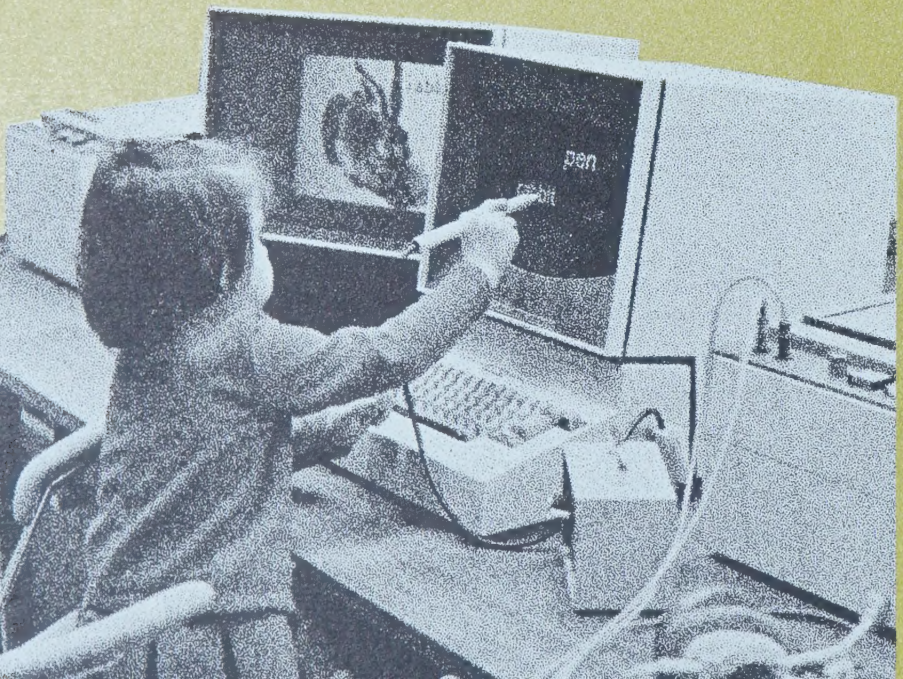
This computer is used for training a small number of teachers, for university course work, and for research into the problems of how children learn. Children as young as three years old have used the computer, and university medical students are learning to recognize heart defects using this same system.

The computing system at Calgary has eight CAI stations, each with a computer-controlled slide projector.

Another unit is now being set up with computer-controlled audio and a touch-sensitive display using ultra-sonic waves projected in two directions across a sheet of glass.

The Calgary unit now has a total of 17 terminals attached to their system. Several of them are already in schools, and it is expected shortly that another four will be placed in schools in Southern Alberta.

This system was developed using a computer small enough to sit on top of a kitchen table and, since December of last year, a trailer has been in operation, transporting the computer learning stations to schools. This permits the students to communicate with the computer via telephone lines.



Computer Assisted Instruction

Potentially, one of the most exciting applications of computer technology for schools is the opportunity it offers for a variety of individually programed instruction modules, catering to the learning pace, ability and disposition of each student.

The essence of CAI is that it permits a maximum of flexibility in its use of a variety of media to present lesson material—typewriter keyboard, television screen using both color and black and white pictures, random access slide projector and tape-recorder unit.

The computer "asks" questions, evaluates the response of the student, provides knowledge of results if correct, then either shows a slide, plays a tape or types out the next question. If the answer is an anticipated wrong answer, a specific clue can be provided and the student again responds to the question. For unanticipated wrong answers, the computer either types out a series of clues or the reason for the correct answer, or branches to a series of small step questions. Because of its ability to make use of a variety of media the computer is able to present the learning process, at the same time encouraging active participation in that process as well as instant feedback of performance.

Although an impressive range of subjects has been programed, the ways in which users have had to respond to course materials have been very restricted. The costs of CAI hardware and CAI courses (whether measured absolutely or on the basis of dollars per student hour of use) are still too high and the programing and administration are still too time consuming for the system to be, at present, a practical tool for widespread use in schools.

In addition, for many educators, CAI is too radical a departure from existing classroom procedures.

There are alternative ways in which the computer can be used to individualize instruction, alternatives less costly and closer to wide scale implementation. Moreover, these alternatives have advantages as interim steps towards CAI. Their application will help to ready educators for CAI when the latter becomes practicable for widespread use.

Computer Managed Instruction

Under present conditions it is often the administration of the learning process which consumes the greatest effort on the part of the educator. This frequently reduces the direct impact his personal attention can have on his students. CMI would free the teacher from some of the time-consuming administrative tasks.

Computer managed instruction provides a means whereby the teacher has at his fingertips all the information necessary to make effective decisions regarding his teaching. For example: assessment of the pace of instruction, selection of materials, ready access to student records, monitoring of student progress, and updating the curriculum.

The system would also have enormous potential for educational research and could be used to develop systems for generating data to be used in research on learning, teaching, curriculum development and evaluation.

Information System for Individualized Instructional Management

Research and Evaluation

- Learning strategies
- Instructional materials and media
- Test items analysis
- Curriculum organization
- Trait studies
- Student-teacher-machine interaction

Instructional Decisions

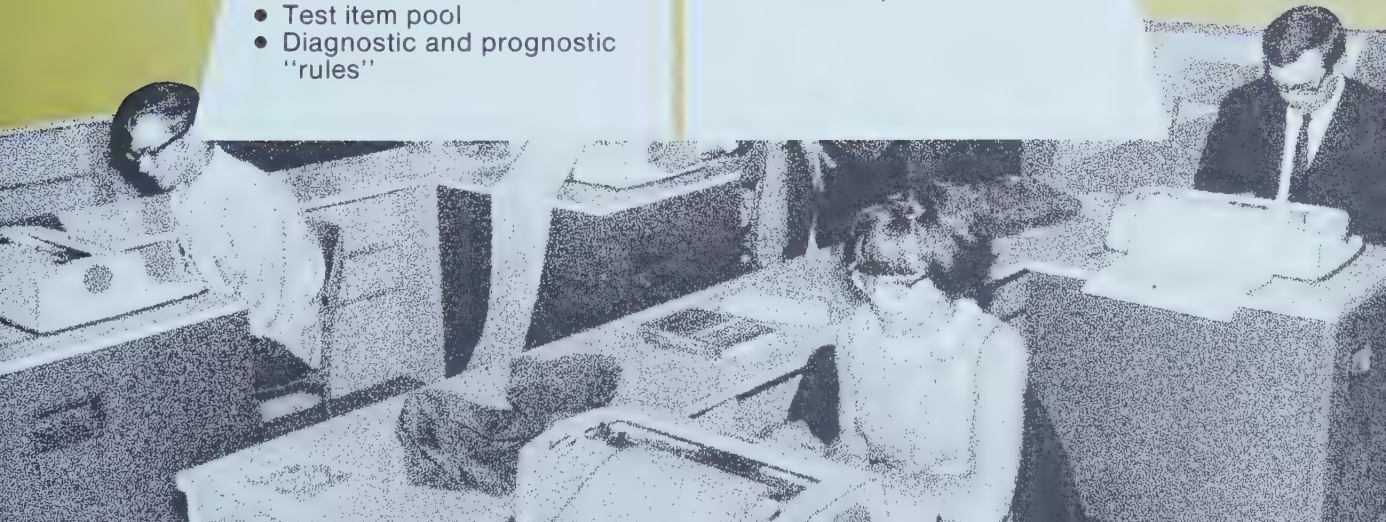
- Instructional objectives
- Instructional materials
- Pace of instruction
- Instructional sequence
- Placement of student
- Testing

Curriculum File

- Behavioral objectives
- Teaching materials and media index and cross-reference
- Test item pool
- Diagnostic and prognostic "rules"

Student File

- Student characteristics
- Student behavior
- Student performance



Simulation

The simulation technique involves establishing a framework in which students are asked to handle a number of interacting variables to produce a solution or conclusion.

For instance, simulation can be used to good advantage in the teaching of history, sociology or similar dynamic subjects. Perhaps, at lower grade level, simple historical chronology might in this way be brought to life; for older students the interacting events of a period—the Industrial Revolution or the American Civil War—can be studied in depth through the use of multi-media stimuli.

Computer simulation has certain advantages over conventional simulation methods (although these advantages may also define the limitations of the technique). One advantage is that a larger number of interacting variables may be introduced and fairly complex, even abstract units, for instance in the field of political science or economics where the technique is quite widely used, can be handled.

In addition, the novelty-pleasure value of multi-media computer usage together with mastery over its technique may well prove important as a motivating factor to the learner.

Diary

During the spring semester, from February to June, 1970, Louis Johnson, a teacher in the Donalda School at Donalda, Alberta, conducted an experimental course, "Introduction to Computer Programming for Junior High School." The course differed in two ways from other courses taught in Alberta: students studied the computer and its uses instead of studying it as an aid in other courses; and, the course was taught to a group consisting of students from grades 7-9.

The course, which explored the possibility and feasibility of its being extended to other classrooms, attempted to give students an understanding of computers, their history and development, capabilities and limitations, and their position in society. It also tried to teach students how to make computers work *for* them.

The course was divided into three sections: history and development of computers; construction of computer programs in BASIC, a computer language, and running them on a teletype terminal in the school; and an introduction to APL and its use on a computer at the University of Alberta. Questionnaires administered before and after the course indicated considerable success in achieving its objectives.

Mr. Johnson conceived the idea of a course in computers for junior high school students, while taking a graduate course at the University of Alberta. He enlisted the support of Alberta Government Telephones, the Division of Educational Research at the University of Alberta, and Canadian General Electric to help him find suitable equipment,

and he obtained financial support from the Human Resources Research Council.

In reporting on his project, Mr. Johnson used an anecdotal record—a "diary" of events during the five months of the course. Here, in Mr. Johnson's own words, are the highlights:

MONDAY, FEBRUARY 2

Today is the day! Now we'll see if the course can live up to its planning.

Questionnaires were given to every student in grades 7, 8 and 9. One class, with four students in it, felt very put upon and said so, loudly.

The teacher was called from the room, and the answers to the questionnaires looked as though there had been considerable conversation about the questions. This will detract from the value of the questionnaires, I expect

TUESDAY, FEBRUARY 3

One grade 10 student, Debbie, enroiled last Fall in a Special Projects course in computers. She wants to become a teacher, so she volunteered, under a little pressure, to teach the history of computers to the class. It sounds like she is going to be a real

MONDAY, FEBRUARY 9

Debbie taught her section in just less than one 40-minute period . . . I remember the first class I taught; Debbie didn't do so badly!

WEDNESDAY, FEBRUARY 18

I missed three periods of classes (skiing can be rough). This has thrown us behind schedule . . . the terminal is to arrive in two weeks, eight class periods.

MONDAY, FEBRUARY 23

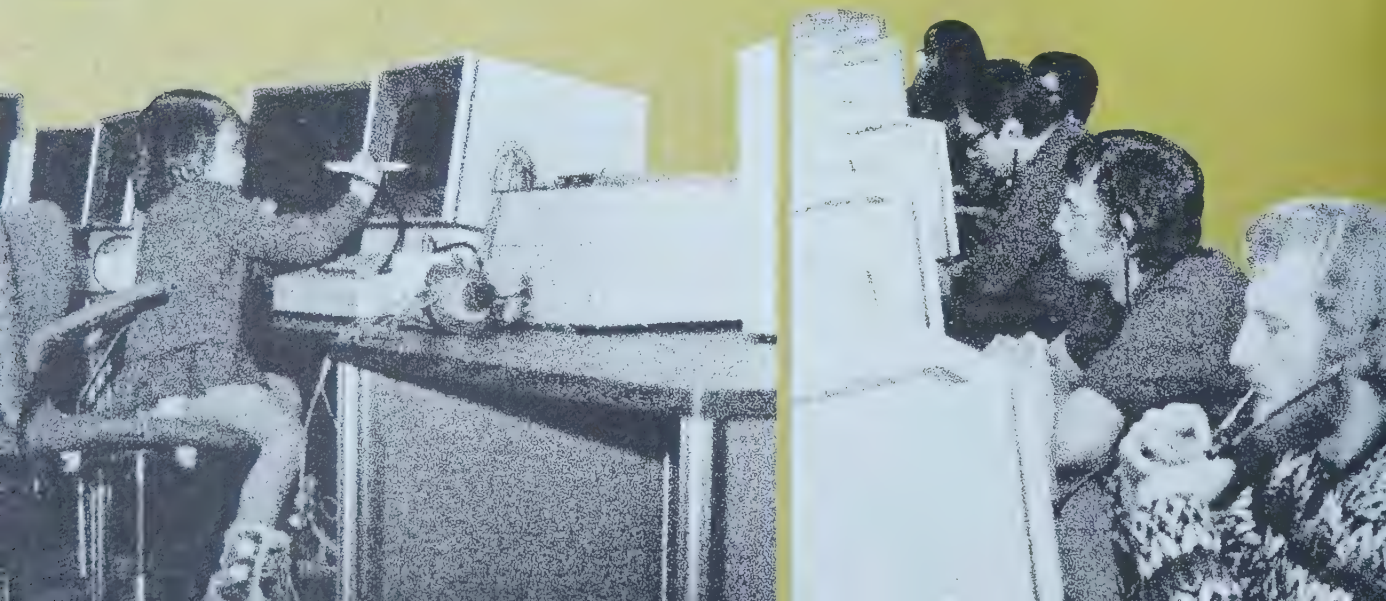
We have launched into flow-charting. Now the kids are happy!

TUESDAY, FEBRUARY 24

I suggested a problem to flow-chart in class. A grade 7 student who is below average had his hand up in about two minutes. He had a perfect chart! I think I have a star!

FRIDAY, FEBRUARY 27

I told the students about a "newspaper reporter" who would be coming after the terminal is installed on March 9. "Hey, Hey, Hey, Man! This course must be something."



WEDNESDAY, MARCH 4

I missed class today but Debbie taught while the substitute watched. I think Debbie liked this . . . The assignment that she gave and the class discussion showed that the students had learned very well. I shall try to use Debbie more, if she is willing.

The terminal was to be installed today, but, when it arrived, the Alberta Government Telephones men who unpacked it discovered that it had been damaged during shipment, and that they required a grounded, 3-wire plug-in which was not available. It will be replaced and installed March 10 or 11.

MONDAY, MARCH 9

The class has been very rushed in its introduction to BASIC. Since the terminal has been delayed, I have dropped back to the first principles and simple commands. Only about 10 of the 30 had kept up in our first try.

WEDNESDAY, MARCH 11

The computer terminal was installed.

FRIDAY, MARCH 13

The User Validation Number arrived . . . I typed some programs onto tape and tried to run them. Garbage! Since I tried a tape I had used in the Canadian General Electric offices in Edmonton. I would say the terminal is goofy.

MONDAY, MARCH 16

The Alberta Government Telephone man located the trouble—the higher frequencies are being dumped . . . as soon as I started the tapes, the computer started dropping symbols on the tape. A trouble shooter in Calgary found my error after talking to me about two minutes.

THURSDAY, MARCH 19

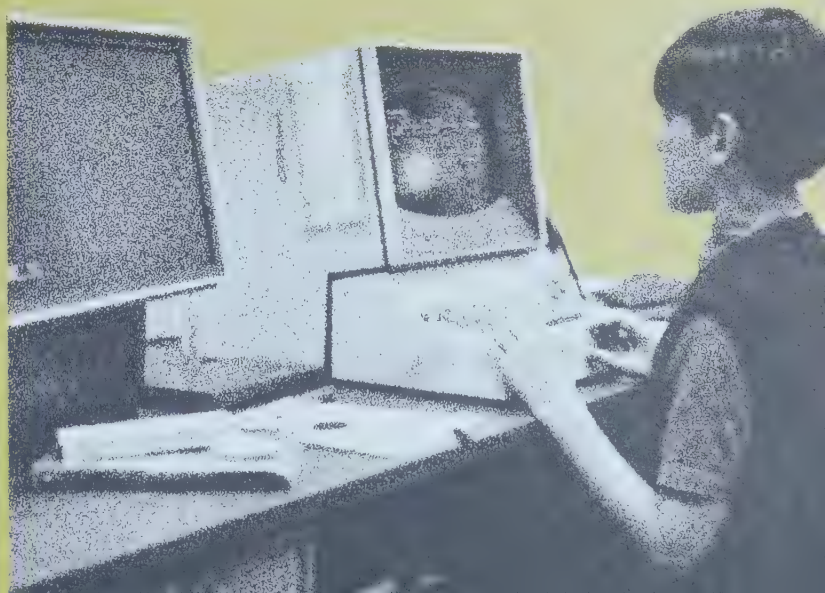
Even though there are no classes on Thursdays, several programs were placed in the input box, so I typed and ran them. Almost none of the programs handed in are perfect. Most contain impossible or useless statements.

WEDNESDAY, MARCH 25

Easter vacation is cutting in next. I've started to get programs that do something besides test commands.

MONDAY, APRIL 6

The students are beginning to sort themselves out



now. About ten are producing complicated programs, like Robby's (Grade 7) which sorts three numbers and prints them in ascending order.

WEDNESDAY, APRIL 8

One student has pulled a cute stunt on me once too often! He has handed in four programs for credit which are remarkably similar. Since I am keeping a folder with copies of each problem, I finally spotted this. When I showed him (I treated it as a joke) he got red, laughed and got to work. I don't know how long his industry will last.

THURSDAY, APRIL 9

I added up the computer time used to date. It will only cost $20.50. I thought we were using up lots of time. Apparently not. Robby made a program to find prime numbers . . . I've posted the printout in the classroom for all to see.

MONDAY, APRIL 13

Another prime program has been built, entirely different from Robby's.

SATURDAY, APRIL 18

I have seen four more Prime Number programs, each of them different.

WEDNESDAY, APRIL 22

I started running programs at 7 p.m. At 8 p.m. Scouts had a meeting in the gym. Eight parents and older brothers and sisters came to the staff room to chat. For two hours we discussed computers and ran simple programs on the computer. These people were very interested in the course and the computer.

THURSDAY, APRIL 23

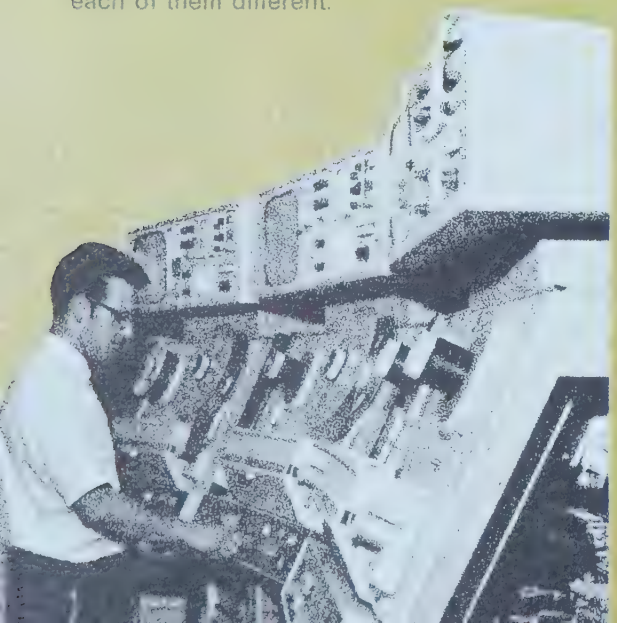
Robby handed in just about the ultimate in Prime Numbers programs . . . I saved it in computer memory for future use.

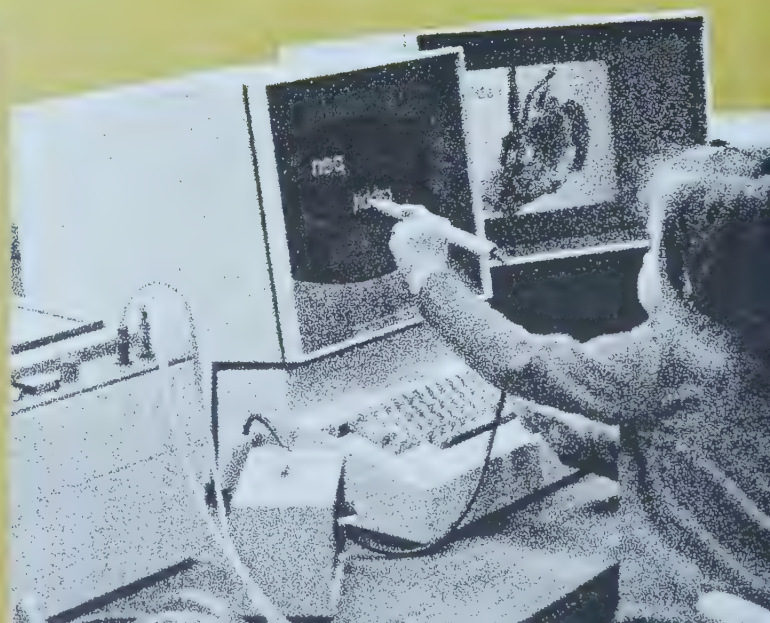
WEDNESDAY, APRIL 29

I have suggested making teaching programs. About eight of the best students jumped at the idea. We could lose the computer terminal as early as May 9, so I have urged every student to rush out any program he wants to run.

MONDAY, MAY 11

Programs have come in by the score. I have been averaging well over an hour per night, five nights a





week, running them. The students have accepted the challenge of the short time left and are really putting out! There are now seven students with good testing or teaching programs, each using different logic in the testing subroutine. These students have learned well how to make the computer work.

SATURDAY, MAY 16

We still haven't lost the terminal. I'm curious and a bit worried. The contract read for two months and I thought they would take it out on May 11. I will stop using the terminal anyway. It's time to go on to the next part of the course.

FRIDAY, MAY 29

I have prepared a booklet introducing APL and will pass it out Monday.

FRIDAY, JUNE 5

A few of the students are interested in APL, but not many. I have arranged with the University of Alberta for a tour of their computers on June 20.

FRIDAY, JUNE 12

That week of hard work making BASIC programs seems to have worn the students out. Maybe they feel they've done enough work for the course. (They really have, I suspect).

SATURDAY, JUNE 20

24 students of the 29 took the tour of the University of Alberta computers. Students saw actual computer circuits and parts, and watched the computer control the mill. In the afternoon, we toured the Computing Center and spent a full two hours working on the computer terminals. The last part was spent in sending messages between terminals, which was more fun than calculating.

WEDNESDAY, JUNE 24

Final questionnaires were given.

I'm afraid that the parents' questionnaires will not get back to me. The school year is nearly over. The course is formally finished.

FRIDAY, JUNE 26

Nine parents' questionnaires came back. My principal and I both feel that this course was very worthwhile for the students. I know that I thoroughly enjoyed every minute of it.

Counselling

In the future, the computer could be made to bear much of the burden of administration and instructional routine previously borne by the teacher himself. But a computer is, and will remain, a machine and can in no way supplant or replace the human element as a source of wisdom, social knowledge and example. Its role should be defined at the outset as essentially one of support, for the education system as a whole, for the individual teacher and for the student.

This support activity can be particularly suitable in areas where, while individual attention to the learner remains essential, the instructional or behavioural unit is standard.

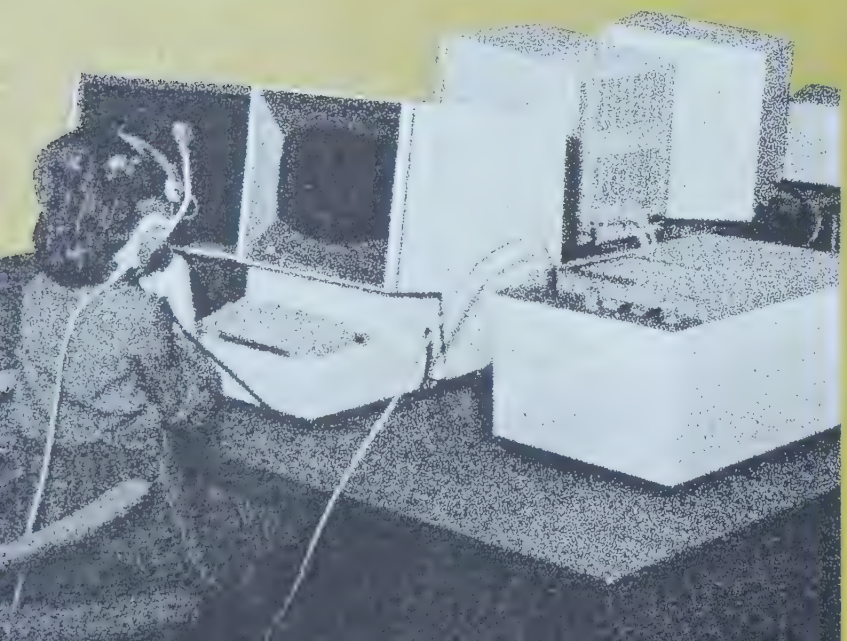
One such area is vocational counselling and many favorable results have been achieved here.

Any vocational counselling system should be planned to accommodate ready revision of its data base. Using computers, this becomes a routine matter.

For counselling purposes, the machine can be programed with details of the student's history, his achievement record and a series of questions designed to elicit information about his vocational interests. By using a typewriter-key / screen combination a wide range of questions can be asked and answered.

It is a primary requirement of this system that the student be enabled to make his own decisions, guided by his own choices of interest area and educational aspiration.

Categories of questions must be broad enough to allow a student to make a ready choice, yet sufficiently precise to accommodate without ambiguity a student already familiar with one of the published inventories of job titles.



Further, categories must be defined in plain language so that they can be understood by all users. As far as possible, the definitions should exclude the possibility of overlapping categories.

Categories are defined on the basis of high school programs (matriculation, business, vocational or general). Beyond high school a student commonly follows a well-defined route —taking an apprenticeship or attending an institute of higher education.

The system can be used either by the student directly as a means of exploring the possible choices confronting him, or by the teacher, as an information retrieval device.

It has been found that this system of direct student-computer counselling was particularly effective for students who felt shy or diffident in approaching the instructor directly.

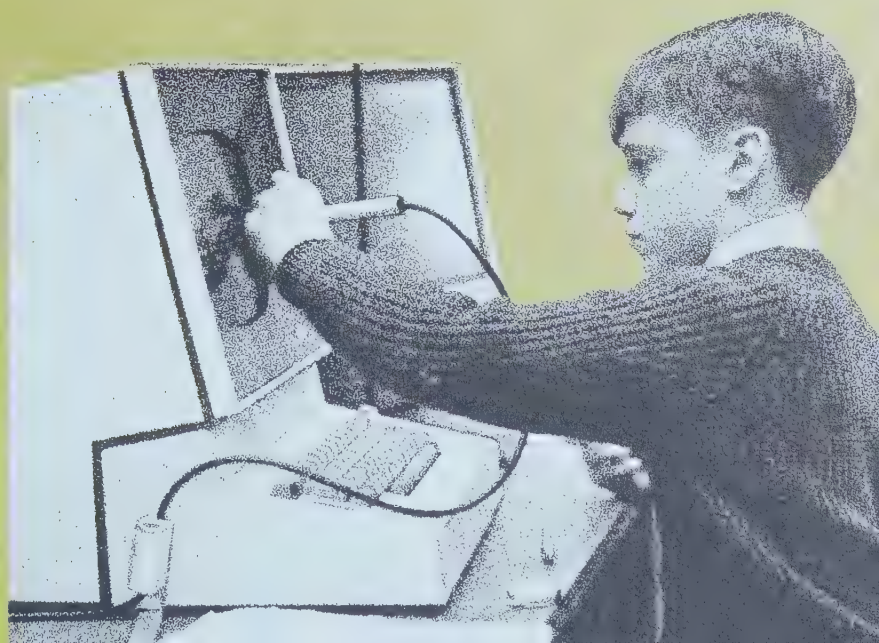
Administrative Applications

In a book on the virtues of the blackboard, Josiah Bumstead wrote in 1841:

"The inventor or introducer of the blackboard system deserves to be ranked among the greatest contributors to learning and science, if not among the greatest benefactors of mankind."

How many of us have heard or read the same things about the computer?

Computer technology confronts school administrators with a wide range of problems and, paradoxically, with a powerful means for solving some of them. It prompts students to carry placards with the words: "STUDENT: DO NOT BEND, FOLD, STAPLE or MUTILATE" but it is often a chief means through which the administrator can develop flexibility in school schedules etc.



It can be a source of aggravation because of its seemingly never-ending demand for paperwork, but it can also free teachers from the tedium of marking examinations, and relieve administrators from routine accounting.

Potentially, at least, computer technology is more than a mixed blessing for the educational administrator. Its capacity to handle large amounts of data quickly and accurately makes it a valuable tool with many possible uses—scheduling of students, staff and facilities; attendance accounting; grading and mark reporting; financial accounting; the preparation of payroll and simplification of many aspects of planning.

These benefits will not come automatically to the administrator. The effective utilization of computer technology in education requires systematic planning, strong leadership, a flexible approach to systems design, realignment of traditional forms of organization. Above all, users must be provided with the skills and confidence they will need to control technology instead of being controlled by it.

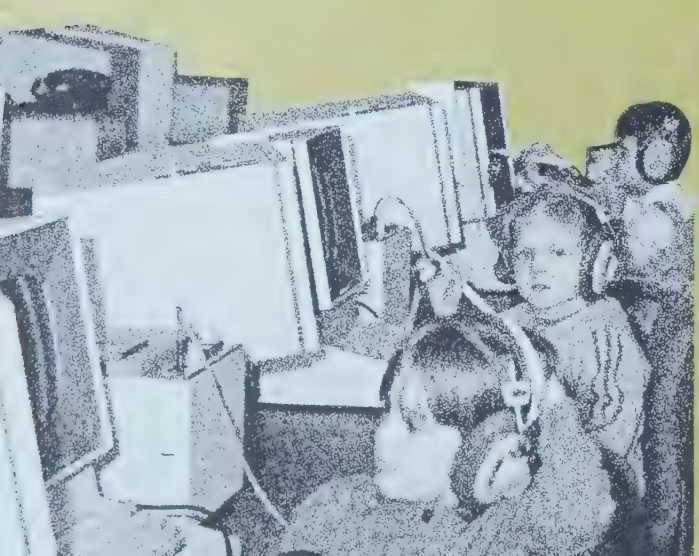
Computer Literacy

If the computer is to become an effective educational tool for the future, both teachers and students must be prepared to accept it and work with it as an integral part of the school system.

Without such initial acceptance, large sums of money for expensive hardware and software will be wasted and much time and energy will count for nothing.

There are two aspects to this question of acceptance: first, a climate favorable to the idea of innovation must be created in a school system. Second, educators themselves will need to be re-trained to acquire and master the knowledge and skills necessary for utilizing computer technology.

Computer literacy could of course be pursued independently, but it is in the context of other project areas that we should be able to generate more complete ideas of what the educational applications of computer technology really are and how these applications can be used to the benefit of all concerned.

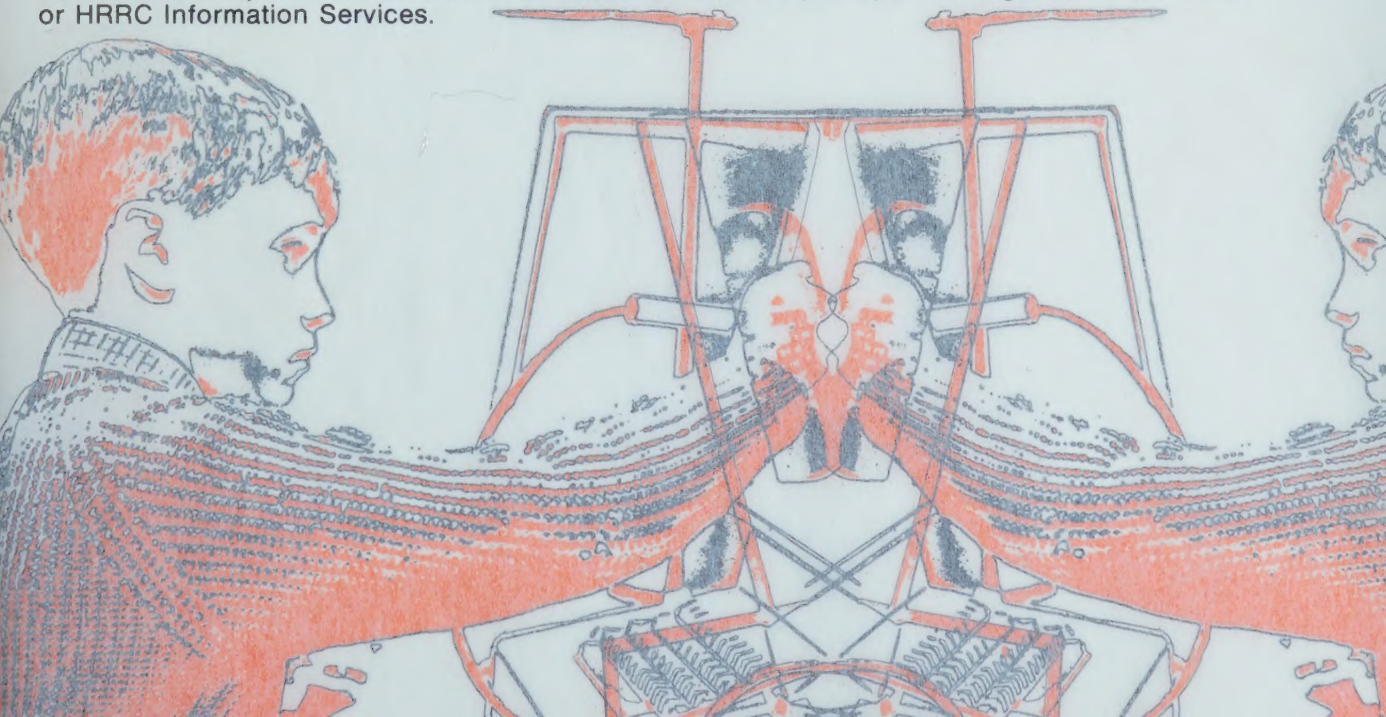


Computer Applications: studies supported by the Human Resources Research Council of Alberta

INVESTIGATOR	PLACE	TITLE
S. Hunka	University of Alberta	Computer Assisted Training Project
S. Hunka	University of Alberta	Development of Peripheral Hardware Control
D. Fitzgerald T. O. Maguire	University of Alberta	An Initiation of Research into Individualized Instruction in Elementary School Mathematics, using Computer Terminals
H. Hallworth	University of Calgary	Development of an IPI Information System
H. Hallworth	University of Calgary	School Scheduling by Computer
H. Hallworth	University of Calgary	Computer Assisted Counselling
H. Hallworth	University of Calgary	Development of CAI Materials for Mathematics Instruction, Drill & Practice.
L. Johnson	Donalda School, Donalda	Introduction to Computer Programing in the Junior High School
J. Bererton	HRRC	Using Computer Technology in Education: a Bibliography

Plus numerous other studies, reports, bibliographies, papers etc.

Your further enquiries will be welcome. Please contact the principal investigator in each case, or HRRC Information Services.

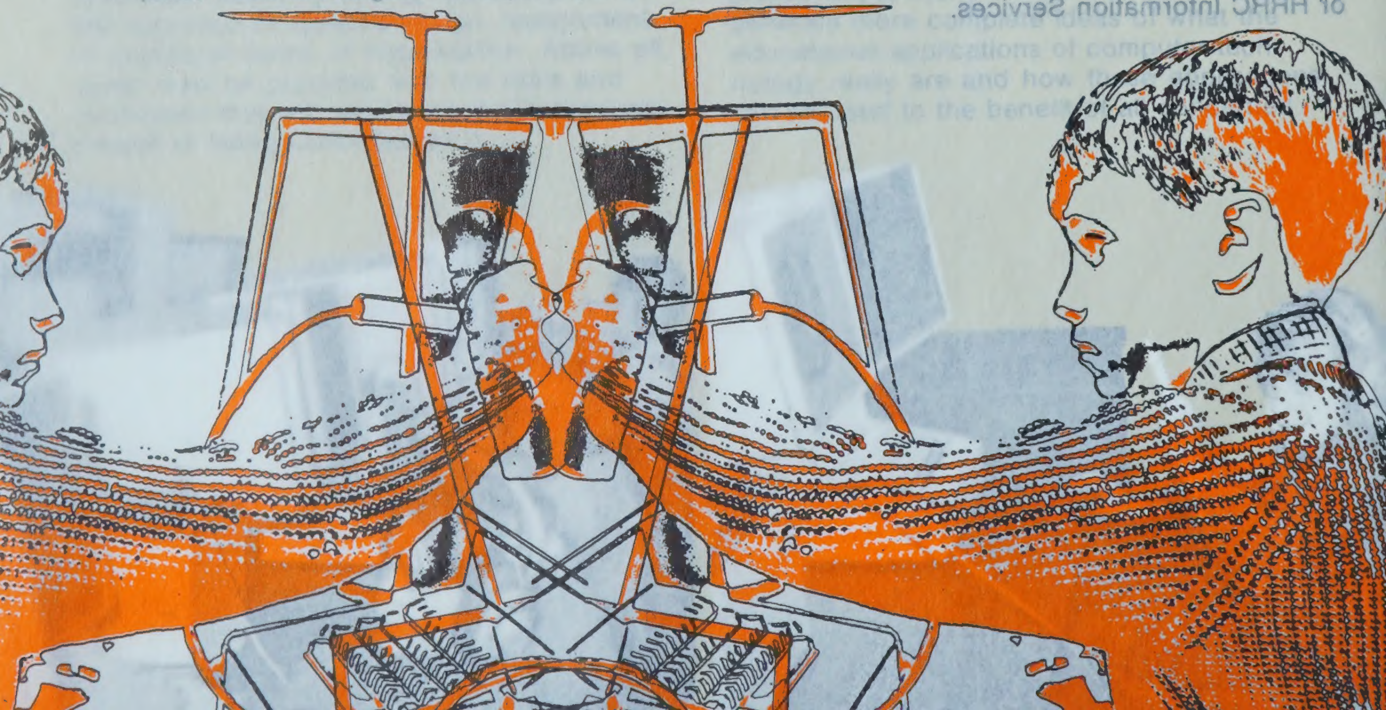


Computer Applications: studies supported by the Human Resources Research Council of Alberta

INVESTIGATOR	PLACE	TITLE
S. Hunka	University of Alberta	Computer Assisted Training Project
S. Hunka	University of Alberta	Development of Peripheral Hardware Control
D. Fitzgerald T. O. Maguire	University of Alberta	An Initiation of Research into Individualized Instruction in Elementary School Mathematics, using Computer Terminals
H. Hallworth	University of Calgary	Development of an IPI Information System
H. Hallworth	University of Calgary	School Scheduling by Computer
H. Hallworth	University of Calgary	Computer Assisted Counselling
H. Hallworth	University of Calgary	Development of CAI Materials for Mathematics Instruction, Drill & Practice.
L. Johnson	Donalda School, Donalda	Introduction to Computer Programing in the Junior High School
J. Bererton	HRRC	Using Computer Technology in Education: a Bibliography

Plus numerous other studies, reports, bibliographies, papers etc.

Your further enquiries will be welcome. Please contact the principal investigator in each case, or HRRC Information Services.



HUMAN RESOURCES RESEARCH COUNCIL

11507–74 Ave., Edmonton, Alberta